

NATIONAL BUREAU OF STANDARDS REPORT

6976

on

Interlaboratory Intercomparisons

of

40-Watt T 12 White Fluorescent Lamps

by

Velma I. Burns

Photometry and Colorimetry Section
Metrology Division



U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers. These papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, and Technical Notes.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards (\$1.25) and its Supplement (\$1.50), available from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

October 1960

NBS REPORT

0201-20-02113

6976

Interlaboratory Intercomparisons

of

40-Watt T 12 White Fluorescent Lamps

by

Velma I. Burns

Photometry and Colorimetry Section

Metrology Division

IMPORTANT NOTICE

NATIONAL BUREAU OF STANDARDS
intended for use within the Government.
to additional evaluation and review
listing of this Report, either in whole
the Office of the Director, National
however, by the Government agency
to reproduce additional copies for

Approved for public release by the
director of the National Institute of
Standards and Technology (NIST)
on October 9, 2015

press accounting documents
ly published it is subjected
roduction, or open-literature
is obtained in writing from
h permission is not needed,
ared if that agency wishes



U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Interlaboratory Intercomparison of 40-Watt T 12 White Fluorescent Lamps

Abstract

A group of twelve 40-watt T 12 white fluorescent lamps were measured by each of eight laboratories. The luminous flux, current, lamp volts, lamp watts, and the x and y chromaticity coordinates were measured. The line voltage was held constant at 236.0 volts across the lamps in series with a reactor having 439 ohms impedance and 7-8% power factor. The results of the measurements made by the individual laboratories and an analysis of the results are given in this report.

1. Introduction

This intercomparison was undertaken to determine the uniformity of measurements on 40-watt T 12 white fluorescent lamps made at the participating laboratories. The laboratories participating and the order of reading are as follows:

- I Sylvania
- II Champion
- III Westinghouse
- IV Duro Test
- V National Bureau of Standards
- VI General Electric
- VII Electrical Testing Laboratories
- VIII Interlectric

The order in which the laboratories made their measurements was chosen to reduce shipment of the lamps as much as possible. Each laboratory followed its own customary procedure in making the measurements. Measurements in each laboratory were obtained by holding the line voltage at 236.0 volts. A reference ballast adjusted to 439 ohms impedance and 7 to 8% power factor was used. The supply was connected to the marked pins.

II Results of Measurements

The results reported are given in tables 1 through 7. The averages reported for each lamp and for each laboratory are given. The difference between the average for each laboratory and the average for all laboratories for all lamps is also given in the tables.

III Analysis of the Results

An analysis of the results of the measurements has been made following a modification of the method described by W. J. Youden (1), (2), and (3). The modified method is described in National Bureau of Standards Report No. 6605 "Interlaboratory Intercomparisons of 32-Watt T10 Cool-White Circline Lamps" and No. 6698 "Interlaboratory Intercomparisons of 40-Watt T12 Cool-White Fluorescent Lamps". The analysis is shown on the following graphs. The point representing the measurements by an individual laboratory is designated by the first letter in the name of the laboratory. The point representing the average of all laboratories is designated by the letter A.

(1) Graphical Diagnosis of Interlaboratory Test Results, Industrial Quality Control Vol. XV No. 11, May 1959.

(2) Product Specifications and Test Procedures, Industrial and Engineering Chemistry, Vol. 50 page 914, October 1958

(3) Circumstances Alter the Cases, Industrial and Engineering Chemistry, Vol. 50, page 77A, December 1958.

NBS Report 6976
October 1960

US COMM NBS DC

Table 1

Luminous Flux in Lumens

Lamp No.	Syl	Champ	West	Duro	NBS	GE	ETL	Interl	Ave.
1	2720	2683	2691	2672	2687	2750	2640	2619	2682.8
2	2706	2668	2690	2670	2687	2769	2690	2628	2688.5
3	2687	2678	2685	2674	2620	2745	2625	2640	2669.2
4	2715	2680	2688	2690	2692	2773	2640	2660	2692.2
5	2712	2694	2711	2688	2687	2770	2645	2660	2695.9
6	2688	2690	2686	2668	2671	2741	2675	2627	2680.8
7	2694	2715	2696	2694	2702	2768	2660	2649	2697.2
8	2696	2663	2699	2678	2671	2750	2625	2634	2677.0
9	2706	2692	2676	2694	2676	2749	2645	2631	2683.6
10	2703	2706	2716	2686	2692	2767	2615	2650	2691.9
11	2687	2676	2698	2673	2687	2765	2620	2652	2682.2
12	2682	2681	2698	2678	2687	2755	2625	2637	2680.4
Ave.	2699.7	2685.5	2694.5	2680.4	2679.9	2758.5	2642.1	2640.6	2685.1
Δ	+14.6	+ .4	+ 9.4	- 4.7	- 5.2	+73.4	-43.0	-44.5	
% Δ	+ .54%	+ .015%	+ .35%	- .18%	- .19%	+2.73%	-1.60%	-1.66%	

Table 2

Lamp Current in Amperes

Lamp No.	Syl	Champ	West	Duro	NBS	GE	ETL	Interl	Ave.
1	.425	.429	.429	.428	.427	.429	.424	.427	.4272
2	.421	.427	.428	.427	.425	.426	.422	.425	.4251
3	.426	.429	.429	.428	.429	.428	.425	.428	.4278
4	.427	.431	.429	.430	.427	.431	.424	.427	.4282
5	.427	.429	.430	.428	.429	.429	.426	.429	.4284
6	.425	.430	.430	.428	.427	.430	.425	.428	.4279
7	.427	.431	.430	.428	.429	.430	.425	.428	.4285
8	.425	.427	.430	.426	.425	.428	.424	.425	.4262
9	.427	.430	.430	.427	.427	.431	.424	.428	.4280
10	.426	.429	.433	.429	.430	.431	.425	.429	.4290
11	.425	.426	.429	.427	.426	.427	.424	.428	.4265
12	.424	.429	.429	.428	.426	.428	.423	.430	.4271
Ave.	.4254	.4289	.4297	.4278	.4272	.4290	.4242	.4277	.4275
Δ	-.0021	+.0014	+.0022	+.0003	-.0003	+.0015	-.0033	+.0002	
% Δ	-.49%	+.33%	+.51%	+.07%	-.07%	+.35%	-.77%	+.05%	

Table 3

Lamp Volts

Lamp No.	Syl	Champ	West	Duro	NBS	GE	ETL	Interl	Ave.
1	102.0	102.4	102.3	102.0	102	101.8	101.8	101.8	102.01
2	104.5	104.1	103.8	104.2	103	103.7	103.7	103.6	103.82
3	102.0	102.7	103.0	102.4	102	102.3	101.8	101.9	102.26
4	101.3	101.1	103.3	101.9	102	100.5	101.0	101.2	101.54
5	102.2	103.3	102.8	102.6	102	102.1	101.4	102.1	102.31
6	101.8	102.8	102.2	102.1	102	101.8	102.0	101.6	102.04
7	101.5	102.5	102.6	102.9	102	101.7	101.4	101.8	102.05
8	103.0	103.9	102.9	103.9	103	103.1	102.9	103.3	103.25
9	100.7	101.4	102.3	101.9	101	100.9	101.4	101.3	101.36
10	102.2	102.8	101.6	102.0	101	101.5	101.6	101.4	101.76
11	102.5	104.0	103.2	102.1	103	103.0	102.8	102.5	102.89
12	103.5	103.2	103.3	102.7	102	102.5	102.7	101.9	102.72
Ave.	102.27	102.85	102.78	102.56	102.08	102.08	102.04	102.03	102.33
Δ	-.06	+.52	+.45	+.23	-.25	-.25	-.29	-.30	
% Δ	-.06%	+.51%	+.44%	+.22%	-.24%	-.24%	-.28%	-.29%	

Table 4

Lamp Watts

Lamp No.	Syl	Champ	West	Duro	NBS	GE	ETL	Interl	Ave.
1	39.7	39.6	39.9	39.8	39.8	40.2	39.8	40.2	39.88
2	40.4	40.5	40.0	40.1	40.1	40.6	39.7	40.9	40.29
3	39.4	39.7	40.0	39.7	39.7	40.5	39.5	40.3	39.85
4	39.5	39.1	40.1	39.1	39.8	39.8	39.6	39.9	39.61
5	39.7	39.9	39.7	39.9	39.6	40.1	39.4	40.2	39.81
6	39.6	39.8	39.9	40.0	39.7	40.2	39.6	40.1	39.86
7	39.6	39.8	39.9	39.9	39.6	40.1	39.5	40.2	39.82
8	40.1	40.1	40.0	40.4	39.9	40.6	39.7	40.9	40.21
9	39.3	39.3	39.8	39.7	39.4	39.9	39.3	39.9	39.58
10	39.7	39.7	39.7	40.0	39.5	40.0	39.6	40.2	39.80
11	39.8	40.1	40.0	40.1	39.9	40.6	40.3	40.7	40.19
12	40.0	40.2	40.1	40.0	39.8	40.4	39.8	40.4	40.09
Ave.	39.73	39.82	39.92	39.89	39.73	40.25	39.65	40.32	39.92
Δ	-.19	-.10	.00	-.03	-.19	+.33	-.27	+.40	
% Δ	-.48%	-.25%	0%	-.08%	-.48%	+.83%	-.68%	+1.00%	

Table 5

Lumens per Watt

Lamp No.	Syl	Champ	West	Duro	NBS	GE	ETL	Interl	Ave.
1	68.5	67.8	67.4	67.1	67.5	68.4	66.3	65.1	67.26
2	67.0	65.9	67.2	66.6	67.0	68.2	67.8	64.3	66.75
3	68.2	67.5	67.1	67.4	66.0	67.8	66.5	65.5	67.00
4	68.7	68.5	67.0	68.8	67.6	69.7	66.7	66.7	67.96
5	68.3	67.5	68.3	67.4	67.9	69.1	67.2	66.2	67.74
6	67.9	67.6	67.3	66.7	67.3	68.2	67.5	65.5	67.25
7	68.0	68.2	67.6	67.5	68.2	69.0	67.3	65.9	67.71
8	67.2	66.4	67.5	66.3	66.9	67.7	66.2	64.4	66.58
9	68.9	68.5	67.2	67.9	67.9	68.9	67.3	65.9	67.81
10	68.1	68.2	68.4	67.2	68.2	69.2	66.1	65.9	67.66
11	67.5	66.7	67.4	66.7	67.3	68.1	65.0	65.2	66.74
12	67.1	66.7	67.3	67.0	67.5	68.2	66.0	65.3	66.89
Ave.	67.95	67.46	67.48	67.22	67.44	68.54	66.66	65.49	67.28
Δ	+ .67	+ .18	+ .20	- .06	+ .16	+ 1.26	- .62	- 1.79	
% Δ	+ 1.00%	+ .27%	+ .30%	- .09%	+ .24%	+ 1.87%	- .92%	- 2.66%	

Table 6

x Coordinate

Lamp No.	Syl	Champ	West	Duro	NBS	GE	ETL	Interl	Ave.
1	.409	.408	.411	.409	.410	.4117	.411	.411	.4101
2	.409	.408	.411	.410	.409	.4110	.411	.411	.4100
3	.409	.406	.411	.409	.409	.4106	.410	.411	.4094
4	.409	.408	.412	.410	.409	.4109	.410	.411	.4100
5	.409	.408	.411	.410	.409	.4105	.409	.412	.4098
6	.409	.408	.411	.410	.409	.4115	.411	.411	.4101
7	.410	.408	.412	.410	.408	.4111	.410	.411	.4100
8	.410	.408	.412	.410	.410	.4105	.410	.411	.4102
9	.410	.408	.412	.410	.409	.4115	.411	.410	.4102
10	.409	.408	.411	.410	.409	.4111	.410	.411	.4099
11	.409	.410	.412	.411	.409	.4108	.410	.412	.4105
12	.410	.408	.412	.410	.409	.4111	.410	.411	.4101
Ave.	.4093	.4080	.4115	.4099	.4091	.4110	.4102	.4111	.4100
Δ	- .0007	- .0020	+ .0015	- .0001	- .0009	+ .0010	+ .0002	+ .0011	

Table 7

y Coordinate

Lamp No.	Syl	Champ	West	Duro	NBS	GE	ETL	Interl	Ave.
1	.397	.401	.401	.399	.398	.3982	.399	.400	.3992
2	.398	.403	.400	.401	.396	.3975	.399	.399	.3992
3	.396	.402	.400	.399	.398	.3976	.398	.400	.3988
4	.397	.400	.400	.401	.398	.3980	.398	.400	.3990
5	.396	.399	.399	.399	.398	.3976	.398	.399	.3982
6	.398	.401	.400	.401	.398	.3992	.399	.401	.3996
7	.397	.401	.400	.401	.397	.3985	.399	.401	.3993
8	.398	.402	.400	.399	.399	.3986	.399	.400	.3994
9	.398	.402	.400	.400	.398	.3988	.399	.401	.3996
10	.398	.401	.399	.400	.398	.3982	.398	.400	.3990
11	.397	.401	.400	.401	.399	.3989	.400	.401	.3997
12	.400	.403	.400	.402	.398	.3987	.398	.401	.4001
Ave.	<u>.3975</u>	<u>.4013</u>	<u>.3999</u>	<u>.4002</u>	<u>.3979</u>	<u>.3983</u>	<u>.3987</u>	<u>.4002</u>	<u>.3992</u>
Δ	-.0017	+.0021	+.0007	+.0010	-.0013	-.0009	-.0005	+.0010	

Figure 1

Lumens

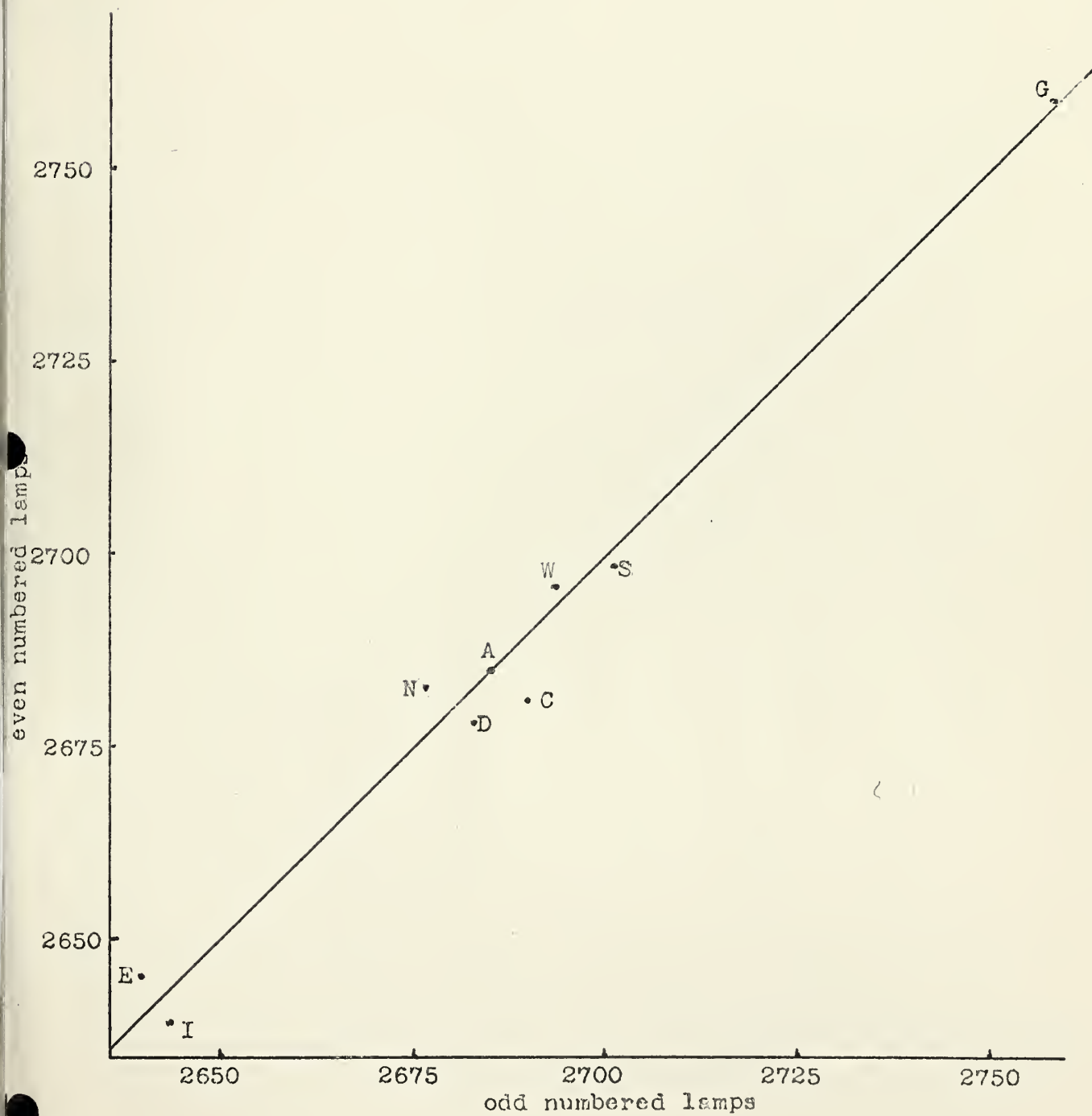


Figure 2

Ampere

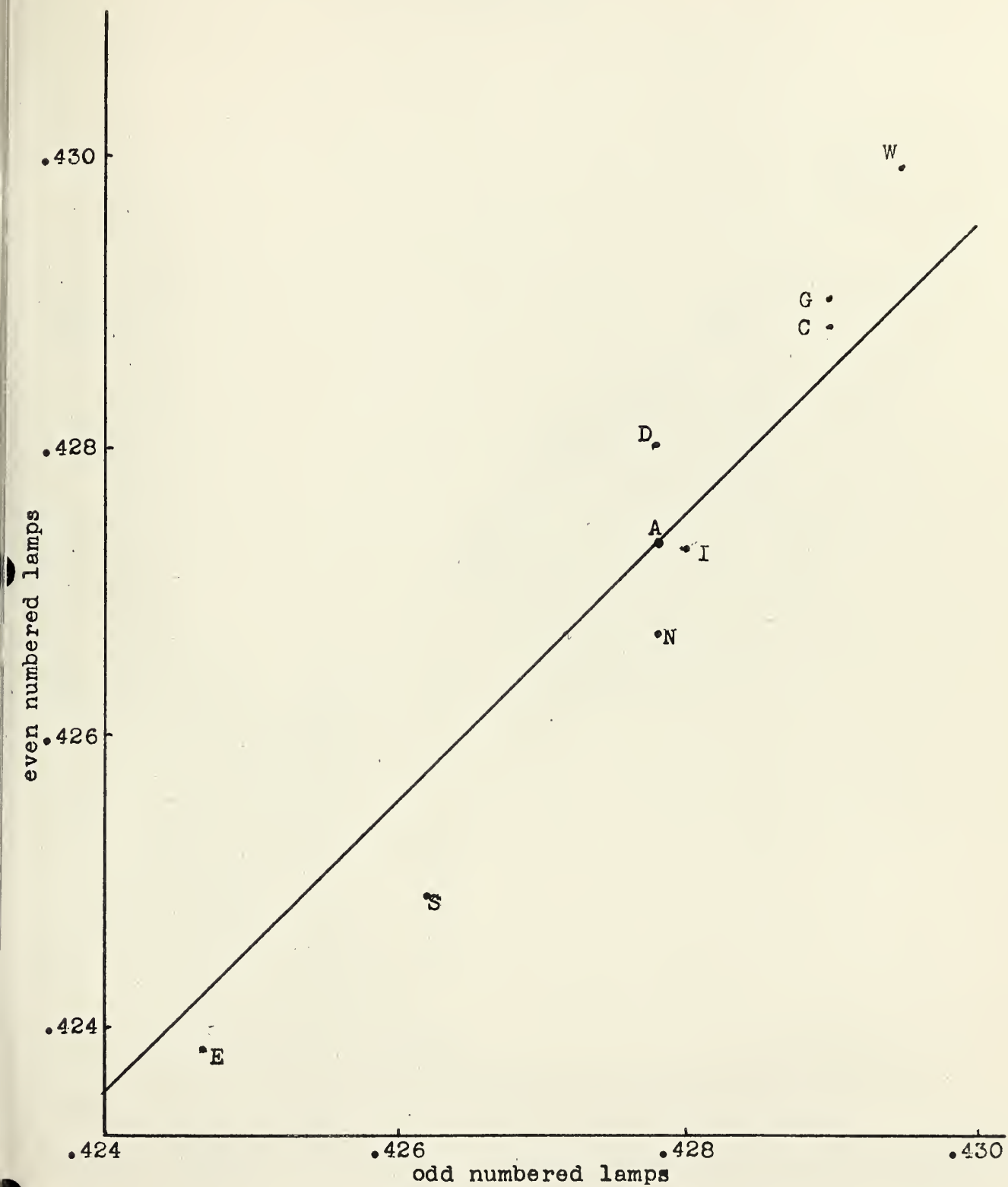


Figure 3
Lamp Volts

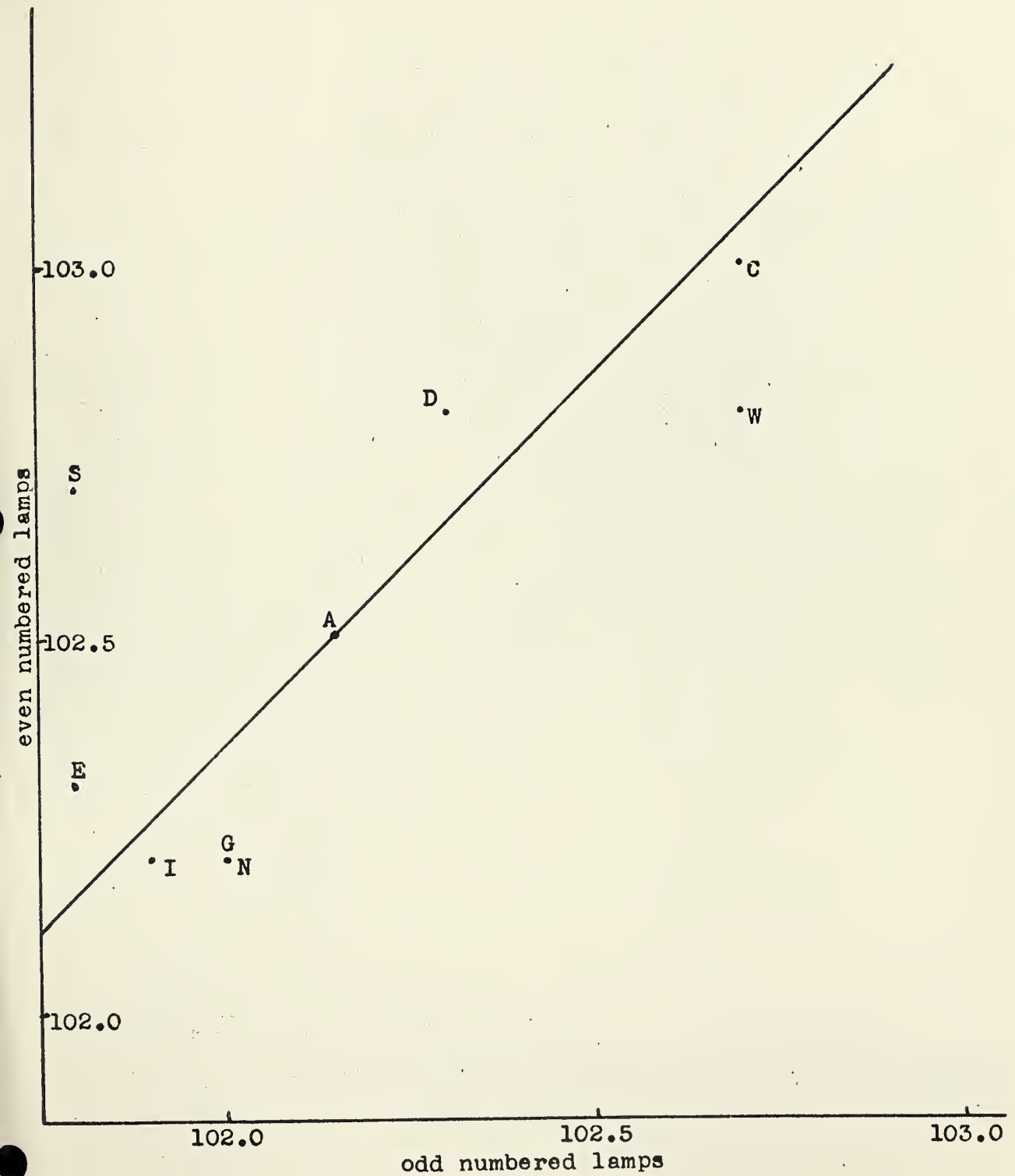


Figure 4
Lamp Watts

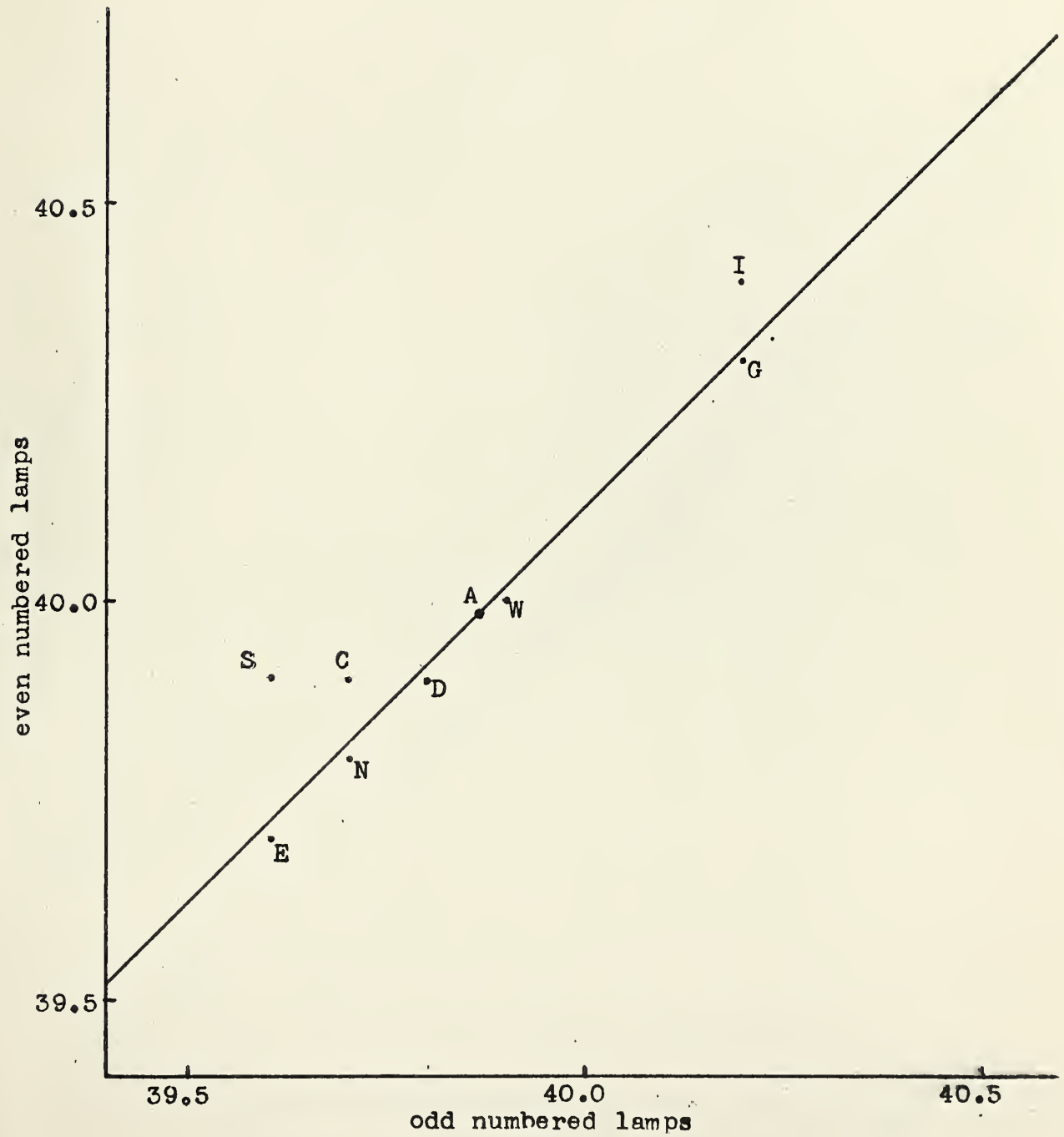


Figure 5
Lumens per Watt

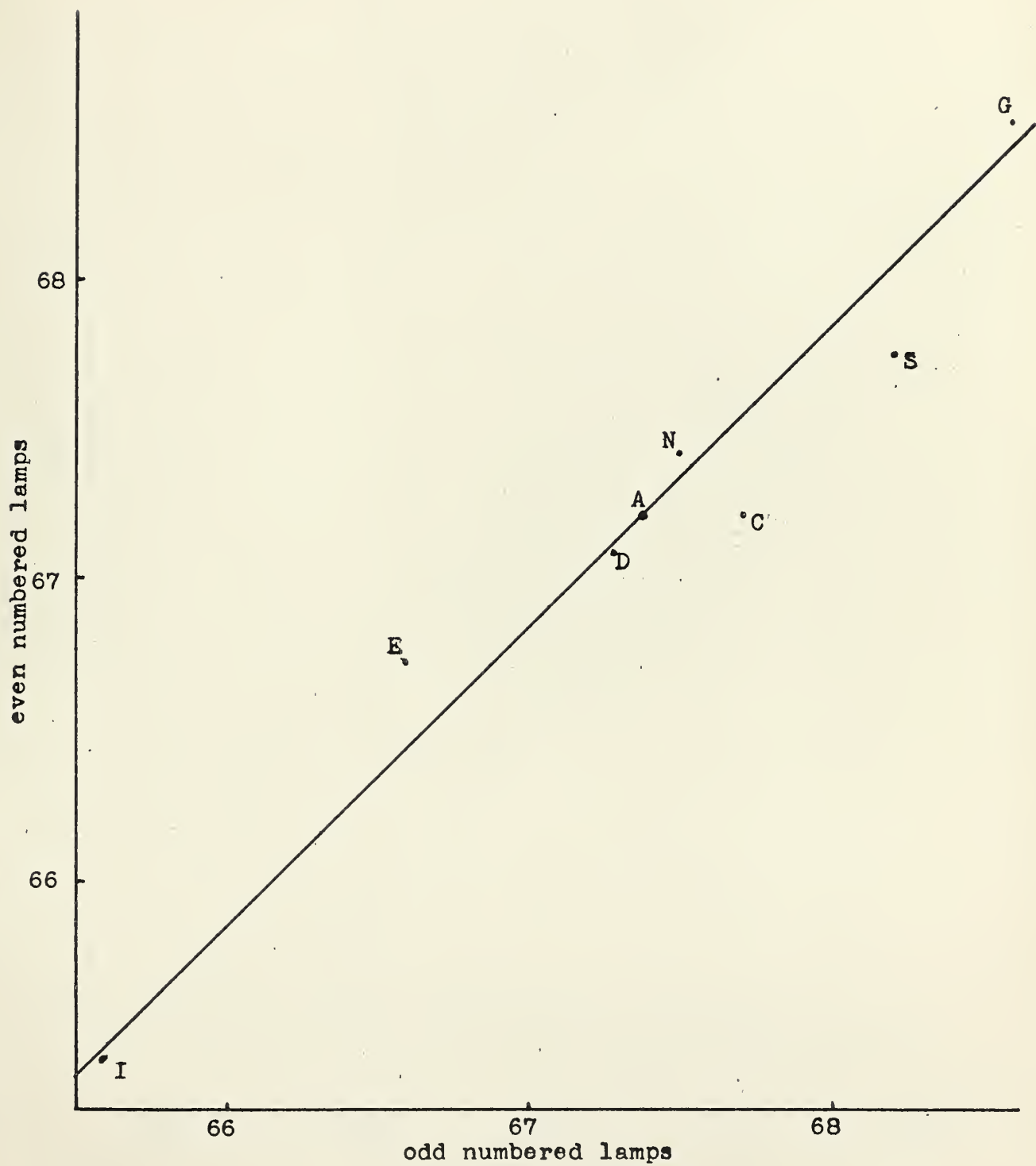


Figure 6
x Coordinate

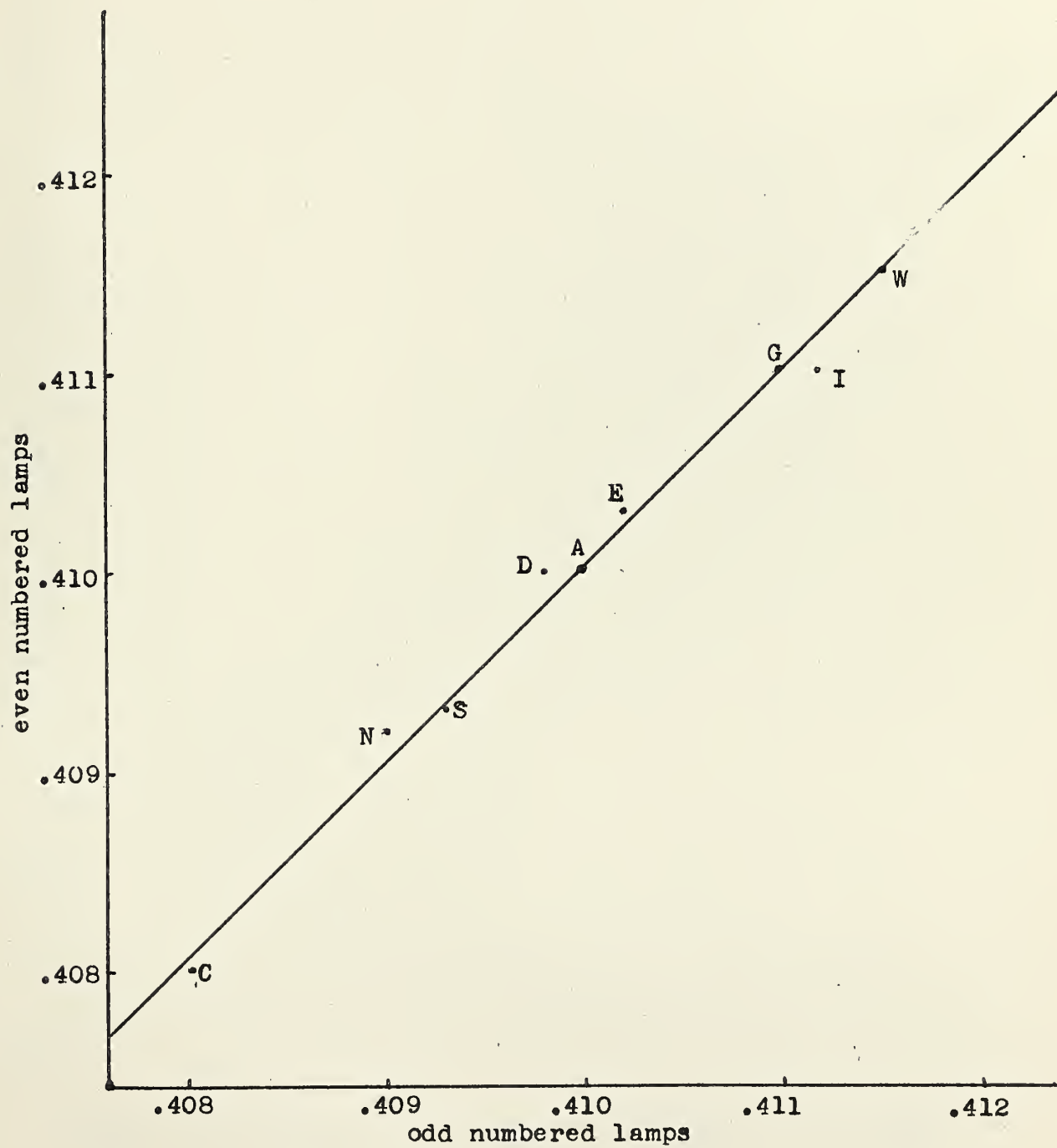
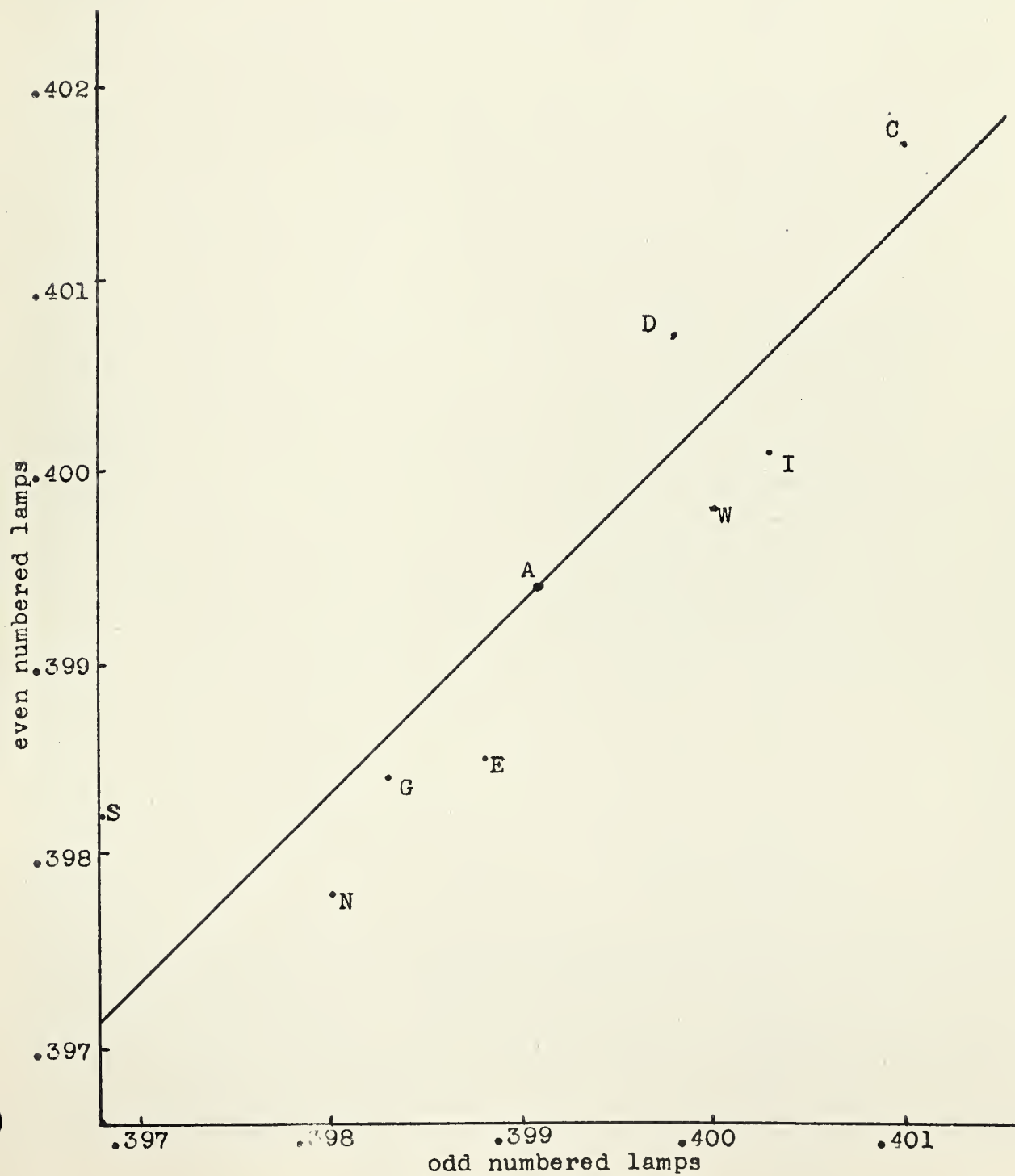
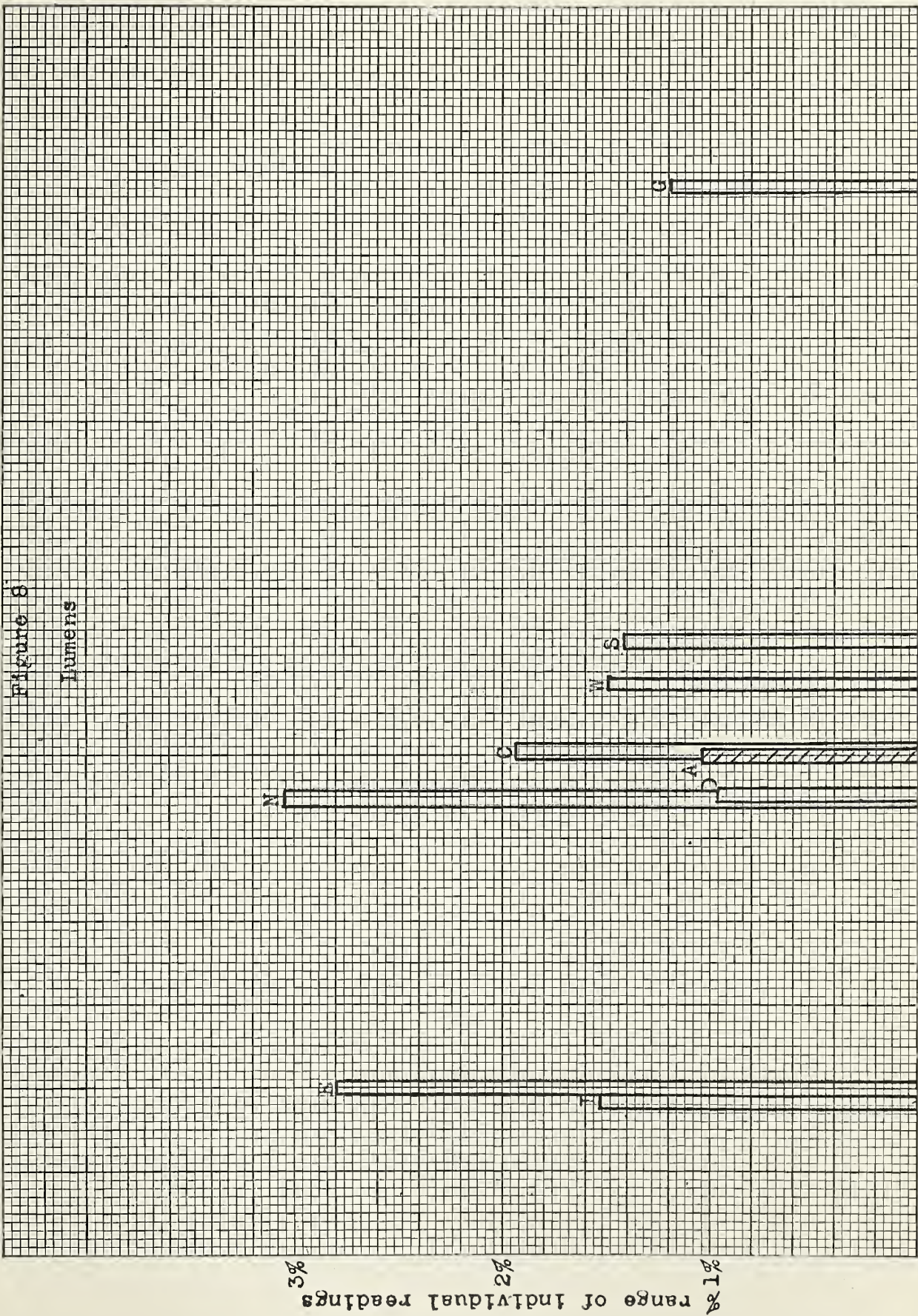


Figure 7
y Coordinate





3%

2%

1%

0

-1%

-2%

% difference from all laboratories average

BS-G-322

22158

11/10/53

G-55

U.S. DEPARTMENT OF COMMERCE

Frederick H. Mueller, *Secretary*

NATIONAL BUREAU OF STANDARDS

A. V. Astin, *Director*



THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colo., is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

ELECTRICITY. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics.

METROLOGY. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

HEAT. Temperature Physics. Heat Measurements. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research. Equation of State. Statistical Physics. Molecular Spectroscopy.

RADIATION PHYSICS. X-Ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

CHEMISTRY. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

MECHANICS. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Combustion Controls.

ORGANIC AND FIBROUS MATERIALS. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

METALLURGY. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

MINERAL PRODUCTS. Engineering Ceramics. Glass. Refractories. Enameled Metals. Constitution and Microstructure.

BUILDING RESEARCH. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials.

APPLIED MATHEMATICS. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

DATA PROCESSING SYSTEMS. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Applications Engineering.

ATOMIC PHYSICS. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics.

INSTRUMENTATION. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

IONOSPHERE RESEARCH AND PROPAGATION. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services.

RADIO PROPAGATION ENGINEERING. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

RADIO STANDARDS. High frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time Standards. Electronic Calibration Center. Millimeter-Wave Research. Microwave Circuit Standards.

RADIO SYSTEMS. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Space Telecommunications.

UPPER ATMOSPHERE AND SPACE PHYSICS. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

